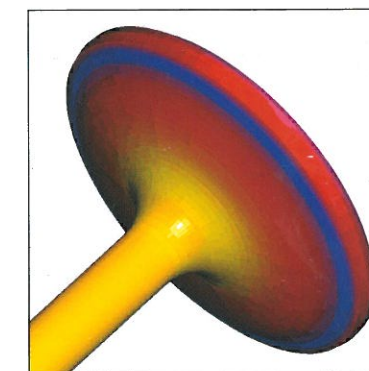


Design and Build

When Luca di Montezemolo became President of Ferrari S.p.A in 1992, he took charge of a Scuderia that was at one of the lowest ebbs in its history and took the first step towards building a new racing organisation by appointing Jean Todt as Team Principal of Scuderia Ferrari, with full responsibility for the Formula 1 programme. What Todt found at Maranello did not fill him with confidence; the people and the facilities were there, but they were not being used effectively. The systems, checks, and methodology that



LEFT: Michael Schumacher accelerates his F1-2000 hard away from one of the Imola chicanes. The load on the inside front wheel is so low at this point that it is clear of the ground as he cuts across the curb at the apex of the corner.

RIGHT: Stress analysis of the Tipo 049 valve head. The greatest stress is in the blue areas, the least in the yellow.

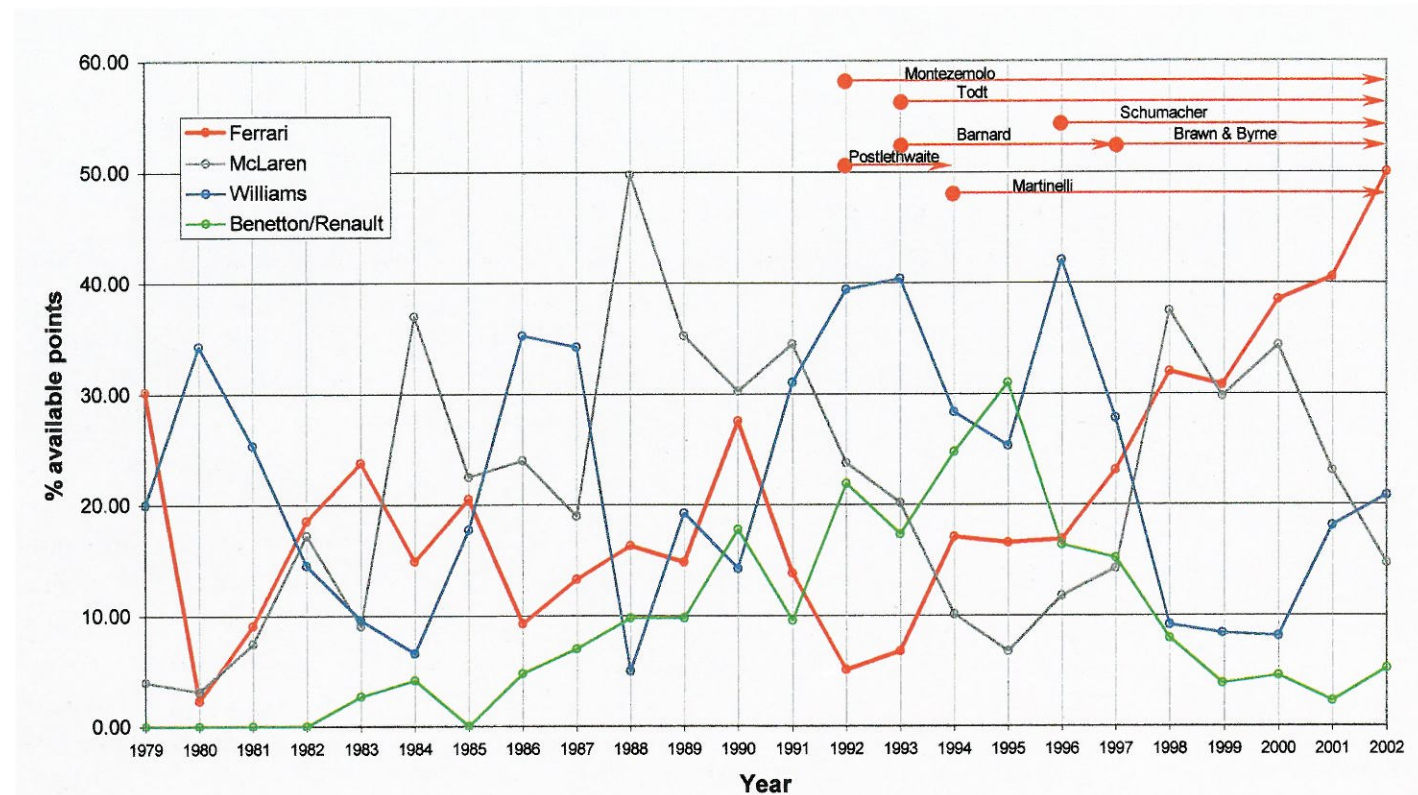
he had installed at Peugeot so effectively were absent. The large workforce had so little focus that its valiant efforts were dissipated in all directions, and the blame for failure was publicly being laid at any door available. Todt had to draw on all the management expertise he had gained while leading Peugeot Sport in the previous eleven years.

What was most lacking was technical leadership. Harvey Postlethwaite was ending his tenure at Ferrari and moving to Tyrrell, and John Barnard was persuaded back to lead chassis design, but the arrangement whereby he based himself and the design department in the United Kingdom, while manufacture, development, and racing were based in Italy was never going to be the answer. Paolo Martinelli

was put in charge of the engine department as it made the transition from V-12s to V-10s for 1996.

ORGANISATION.

Todt soon realised that without the right people in the key technical positions, success would not be possible. There are very few designers and engineers with the proven capability of regularly winning championships. McLaren was just entering its post-Honda loss of form, and Williams, with its engine partner Renault, was in the ascendancy. Coming up fast on the inside was Benetton's unproven combination of driver and engineers, Michael Schumacher, Ross Brawn, and Rory Byrne. When they took the World Championship from



Williams in 1994 and 1995, Todt knew whom he wanted. With Schumacher in place for 1996, it only took that year to persuade Brawn and Byrne to complete the team, with Brawn as Technical Director and Byrne as Chief Designer of the car. Martinelli's V-10s were the equal of the opposition, and Schumacher started to deliver results. Williams' fortunes entered a downturn when Renault withdrew from Formula 1 at the end of 1996, and McLaren started to rise again with Mercedes' involvement and Mika Hakkinen's increasing maturity as a driver. From 1998 to 2000, the World Championship was a straight fight between Ferrari and McLaren, Schumacher and Hakkinen, apart from the second half of 1999 after Schumacher's crash at Silverstone. The accident left Schumacher with a broken leg, and he missed the next six races as a consequence. After Silverstone, Eddie Irvine carried Ferrari's challenge forward.

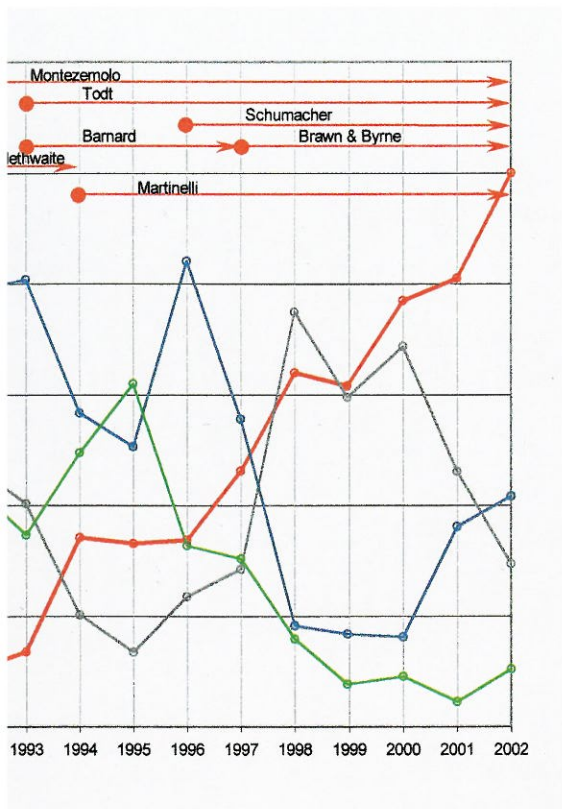
In 1999, they won the Manufacturers' Championship and would probably have taken the Drivers' Championship, too, if Schumacher had not been injured. Schumacher was able to return for the last two races and assist Irvine's championship battle with Hakkinen, which Irvine only lost in the final race in Japan.

When Brawn and Byrne arrived at the end of 1996 and beginning of 1997, respectively, they inherited John Barnard's F310 but no chassis design department, as all work in this area had been carried out in the U.K., and the staff at Maranello had been moved to other areas. For 1997, an extensively rebodied F310B benefited from Byrne's aerodynamic input, and a Mark 2 version of the 046 engine was used. Meanwhile, Brawn set about creating a chassis department virtually from scratch.

Brawn considers '97, '98, and '99 to have been catch-up

LEFT: [Fig. 3-3] The Manufacturers' World Championship points. Ferrari's improvement since 1993 is evident and significantly more prolonged than any other recovery by its main competitors.

RIGHT: Ross Brawn, Technical Director, and Paolo Martinelli, Director of Engines, head the Scuderia's technical organisation that created the Ferrari F1-2000, reporting to Jean Todt, Team Principal.



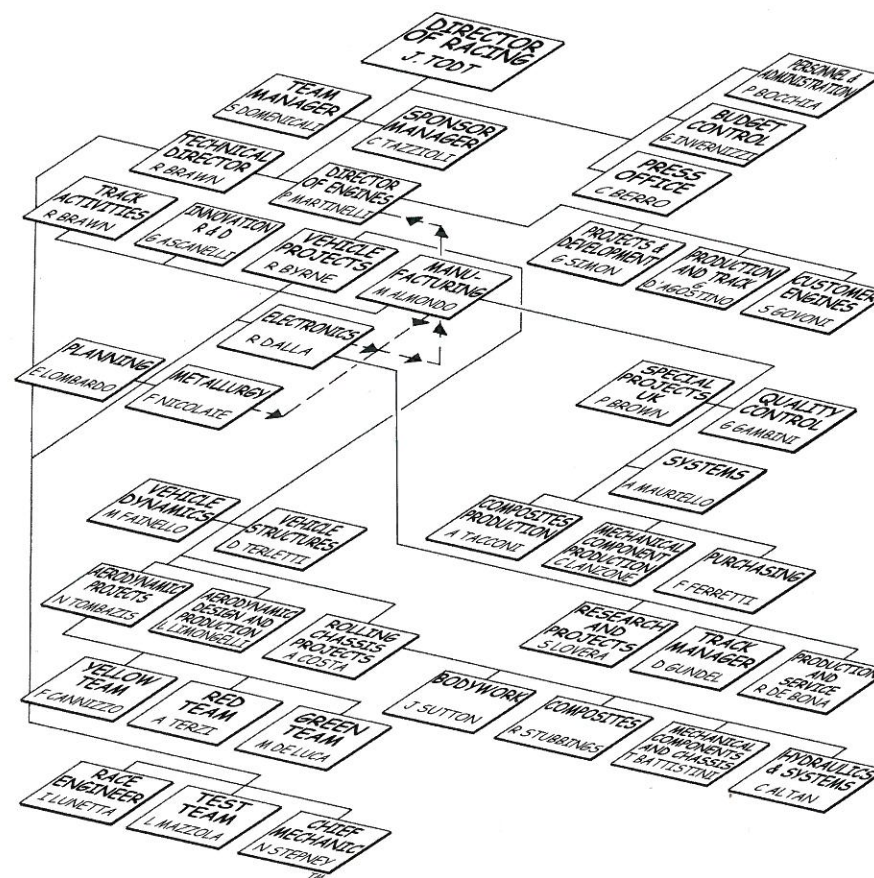
they won the Manufacturers' Championship and have taken the Drivers' Championship, too, had not been injured. Schumacher was able to win the last two races and assist Irvine's championship victory, which Irvine only lost in the final race.

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years, where they arrived at the first race of each year to discover they were half a second or more off the pace. They relied on Schumacher to be competitive, though in each year they steadily improved to end the seasons close to McLaren. It was only in 2000 that they felt they had a car that was truly competitive at enough of the circuits to really achieve their goal of winning both championships. The first race in Melbourne confirmed this with a one-two finish for Schumacher and Barrichello. The strength and quality of the organisation that Todt, Brawn, Byrne, and Martinelli have created can best be judged by Ferrari's performance in the World Championship, from the low point in the early '90s to today. In 2002, Ferrari



scored 50 percent of all the points available (first and second in every race would only yield 61.5 percent of the points); at no time in the previous 30 years has such a steady rise in performance been seen in Formula 1 (Figure 3-3).

The technical organisation that created the Ferrari F1-2000 is shown at left. Jean Todt, as Team Principal, has the overall responsibility for the Scuderia's activities, including technical aspects, logistics, sponsorship, public and press relations, and administration. Ross Brawn, Technical Director, and Paolo Martinelli, Director of Engines, both report directly to Todt. Brawn has overall responsibility for the whole car and for manufacturing, which is an unusual area for a Technical Director to take on. Martinelli has overall control of the engine programmes, while Brawn has the additional role of being responsible for all activities at the track. They also share a number of specialist departments. Rory Byrne, Head of Vehicle Planning, directs all the vehicle programmes and reports to Brawn. Byrne controls chassis and gearbox design, aerodynamics, vehicle dynamics analysis, and structures. Research and Development, under Giorgio Ascanelli, reports to Brawn, as does Manufacturing under Mario Almondo. The race team is managed by Stefano Domenicali, and the Chief Mechanic is Nigel Stepney, who also has responsibility for the race shop, reporting on all technical matters to Brawn.

PROGRAMME.

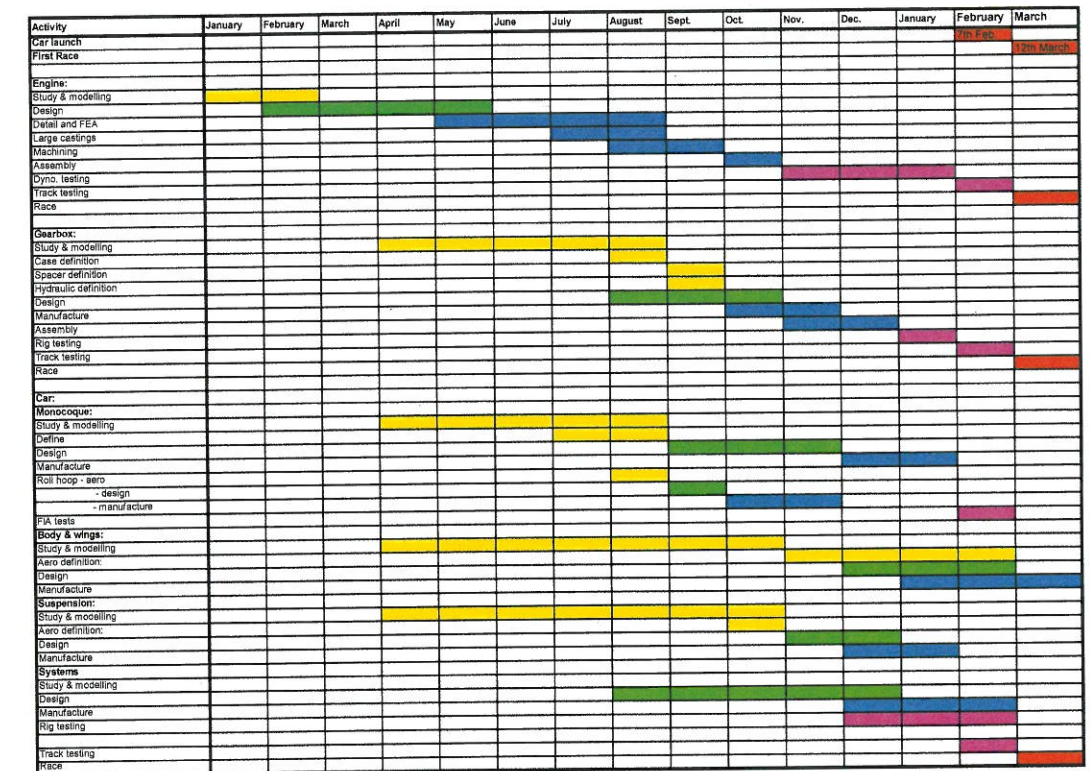
As soon as a new engine or car runs and the qualities and deficiencies of the new design can be assessed, team members' thoughts turn to the next one.

Figure 3-5 on the following page illustrates the scheduling of the main parts of a new car. Engine concept work starts in January, as soon as dynamometer testing is well under way on the engine to be raced that year. New car work starts in earnest as soon as the race season is under way in March.

Ross Brawn describes the process: "When we get back from the initial races of the new car, and we have seen how it compares with the new cars of our competitors, we sit down and start the process of specifying next year's car. From around April, we then have a new car meeting every two weeks throughout the season, which starts with just a small number of people—Paolo and Rory, of course—and gradually expands as design, analysis, and R&D people come in on the discussions.

"We try to analyse the strengths and weaknesses of our car relative to competitors and determine what changes, either to the overall performance of some aspect, or the compromises we have to make. For instance, we decide on fuel tank size, and the resulting wheelbase, and pitch and yaw inertias fairly early on, and try to come up with a configuration that works best on the greatest number of tracks. The trend has been towards larger and larger fuel tanks, to enable the driver to run the longest possible first stint, but that leads to a longer wheel base and the displacement of heavy components away from the centre of gravity [C of G], to make space for the fuel."

Ferrari has found that pitch motion (about the horizontal transverse axis through the C of G) and yaw motion (about the vertical axis through the C of G) are both important aspects of car performance, and as the inertias about these axes both increase with wheelbase, they are affected by fuel tank size. In particular, the vehicle dynamics department has found that the car is sensitive to the pitch inertia effects, as well as the more obvious yaw inertia. It has run extensive analysis on the trade-off for all circuits, and tank size has been chosen on the information gleaned, as well as from race strategy considerations. It is in making decisions such as this that Ross Brawn excels, where overall race performance, on average more than seventeen circuits, is a function of different factors, involving different disciplines.



Brawn says: "We set targets for weight reduction as we want to put as much ballast low down in the car as possible and to be able to move it around to tune the car. We decide on the areas where a particular weight reduction is possible and may then run lighter components during the season to check for reliability and be able to confirm those parts of the design.

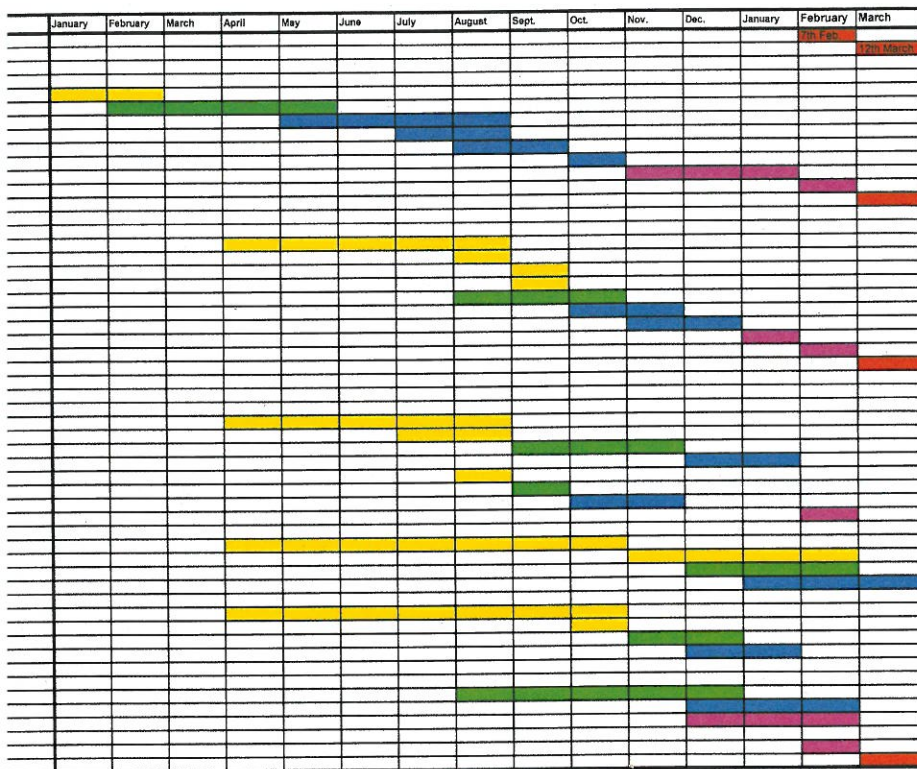
"Tyre degradation is always an issue, and we shall do considerable analysis to identify areas where increasing camber and toe stiffness, for instance, can reduce degradation.

"We try not to involve Rory in day-to-day racing and the reliability issues it inevitably throws up, so that he can get on with the new car. He is tracking the output from three shifts in the wind tunnel, as well as directing the design of the chassis and transmission. The longer the aero-

ABOVE: [Fig. 3-5] The schedule to research, design, build, test, and prepare a Formula 1 car for the first race varies little each year. The amount of work, however, increases steadily for a team such as Ferrari.

RIGHT: Stress analysis of the Tipo 049 connecting rod little end. The greatest stress is in the blue areas, the least in the yellow, according to the scale.

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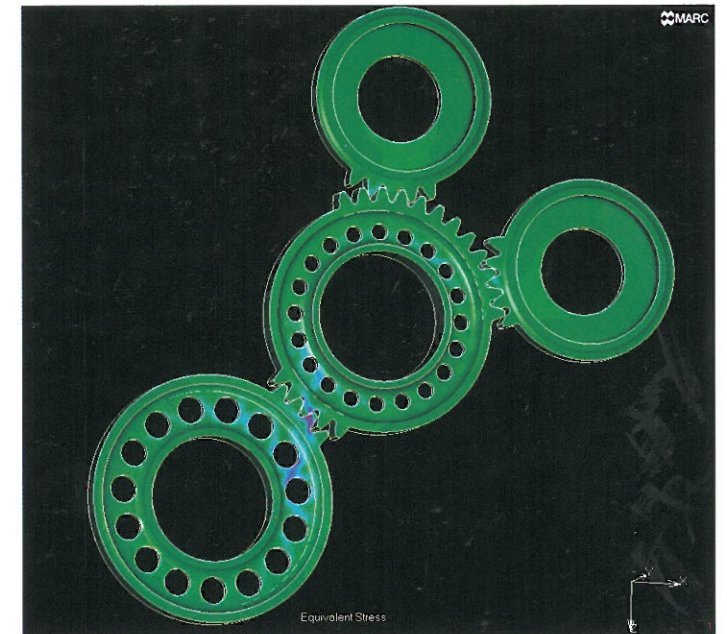
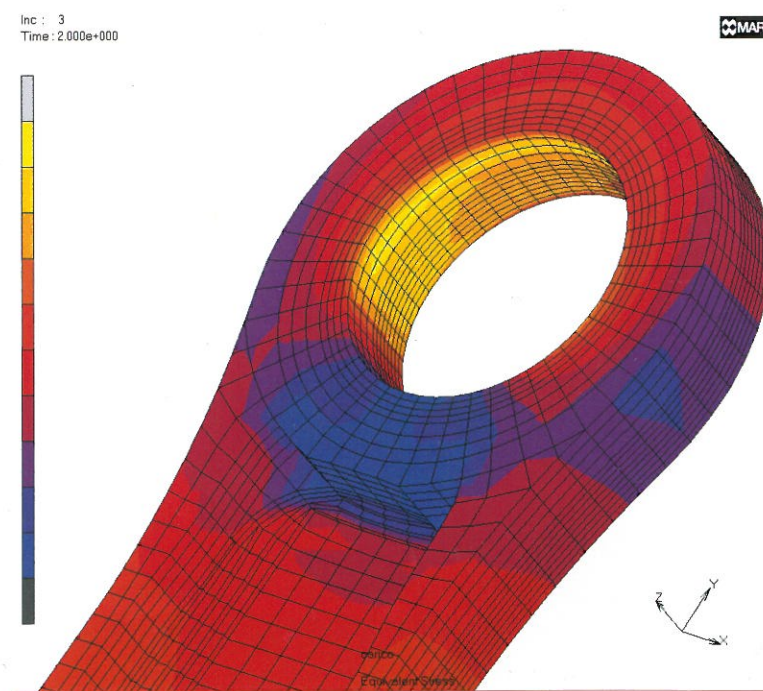
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FAR RIGHT: Finite element analysis (FEA) provides the designer with the ability to fine-tune components for maximum lightness without exceeding critical stresses. These are the Tipo 049 engine timing gears.

dynamicists can spend in the tunnel before the design is frozen, generally the greater the gains they come up with. The monocoque pattern must be started around August, but Rory may come to a meeting with a request for another couple of weeks to achieve a significant gain, and I have to see how things can be shuffled to give him the extra time. The planning department has to interleave the changing requirements of both engine and chassis build and see how critical facilities can be rescheduled."

The schedule in Figure 3-5 does not start to illustrate the complexity of the planning required to design and build a small batch of Formula 1 cars in just twelve months, while at the same time developing and supplying the racing department with components for the current car. Even a team with the funding and facilities of Ferrari has limitations on its resources. The loading of designers and their CAD and CAM (computer aided manufacturing) facilities; CFD, FEA,



and vehicle dynamics analysts and workstations; rapid prototyping machines; the foundry, machine shop, and composites departments; rig shops; wind tunnels; dynamometers; and even the track test programmes must all be planned in minute detail and in such a way that it is also flexible enough to respond to the unexpected. Ferrari has recently built a large logistics centre alongside the Fiorano test track, to handle the preparation, storage, and transportation needs of the race and test teams.

Ferrari works closely with its technical partners, integrating them more closely into the design and development process than perhaps any other Formula 1 team. This close involvement of outside companies inevitably leads to the need for many meetings, often involving time-consuming overseas travel by key personnel. As the relationships strengthen and become closer, a process brought about by mutual success more than anything else, the exchange of data expands. Race strategies depend on information and decisions made jointly, and Ferrari's technical partners are an integral part of the planning and execution of races.